Background: Importance of Clouds

Clouds are an extremely important component of the earth system and directly affect energy and moisture transport, which in turn affect many biological processes. Cloud dynamics can vary drastically over small spatial (~2 km) grains due to atmospheric circulation, topography, and even land cover. However, existing cloud products are available only at relatively coarse spatial grains (8-110 km). Furthermore, the standard MODIS cloud flag (MOD35) contains significant land-cover and processing artifacts that make it unsuitable for spatially consistent analysis (Wilson, Parmentier, and Jetz, 2013). In this study we develop a new MODIS-derived 1-km cloud climatology (MODCF) for use in ecological and species distribution modeling.

Methods: MODIS Climatology

Daily MODIS Cloud Flags
Cloud flags from the 1-km MCD09GA (PGE11) algorithm were extracted from February 2000 - March 2014 (n=250TB) and summarized into monthly cloud frequencies (proportion of days with positive cloud flag).

Monthly Climatologies
The monthly cloud frequencies were summarized into the inter-annual mean (and standard deviation) cloud frequencies.

Removal of Orbital Artifacts
A Bayesian image restoration method (Fehrenbach, et al, 2012) was used to identify and remove bands resulting from variable observation frequency due to the MODIS orbit.

Validation
The monthly cloud frequencies were validated using a global observational dataset of synoptic weather reports collected at over 5,300 stations over 1971-2009 (Eastman and Warren 2012).

Derived Metrics
The monthly mean and standard deviation were used to generate additional biologically relevant metrics such as inter- and intra-annual variability.

Results

Mean Annual Cloud Frequency (%)

Validation Mean Cloud Frequency (%)

Validation

MODCF was nearly as accurate over the full time period (1970-2009) versus the MODIS-era stations.

MODCF captures nearly 80% of the variability in cloud cover observed at a global set of validation stations.

MODCF was nearly as accurate over the full time period (1970-2009) versus the MODIS-era (2000-2009) alone, suggesting that it is a useful metric of multi-decadal fine-grain cloud frequency.

Conclusions & Applications

Conclusions
The MODIS MOD09GA cloud flag was used to develop a 1-km global cloud frequency dataset (MODCF) useful for ecological and biogeographical research.

MODCF captures nearly 80% of the variability in cloud cover observed at a global set of validation stations.

MODCF was nearly as accurate over the full time period (1970-2009) versus the MODIS-era (2000-2009) alone, suggesting that it is a useful metric of multi-decadal fine-grain cloud frequency.

Applications
MODCF will contribute to a set of 1-km environment and climate layers developed for global biodiversity and ecosystem modeling under the NASA sponsored EarthEnv project (see earthenv.org).

MODCF is currently being used to develop global 1-km solar radiation maps and will soon be applied in the interpolation of precipitation.

References

